A3 cont'd

difference between the combined axial force determined prior to adjusting the at least one initial design parameter.

A4

16. (Amended) A method for balancing a volume of formation cut by each one of a plurality of roller cones on a drill bit drilling in earth formations, comprising:

selecting bit design parameters, comprising at least a geometry of a cutting element on the drill bit;

selecting at least one characteristic of an earth formation to be simulated as being drilled by the drill bit;

simulating drilling of the drill bit through the earth formation, the simulating comprising calculating from the selected bit design parameters and the selected earth formation characteristic, parameters for a crater formed when each one of a plurality of cutting elements on each of the roller cones contacts the earth formation, the parameters including at least a volume of the crater, simulating incrementally rotating the bit, and repeating the calculating of the crater parameters for a selected number of simulated incremental rotations;

combining the volume of each crater formed by each of the cutting elements on each of the roller cones to determine the volume of formation cut by each of the roller cones; and

adjusting at least one of the bit design parameters, and repeating the simulating until a difference between the combined volume cut by each of the cones is less than the combined volume determined prior to the adjusting the at least one of the bit design parameters.

Sl C1

REMARKS

Please reconsider the application in view of the above amendments and the following remarks.

The Applicants wish to thank the Examiner for careful review of their lengthy specification and claims. In the Office Action dated August 9, 2001, the Examiner rejected claims 1-28 for failure to recite statutory subject matter. The Applicants have amended claims independent claims 1, 5, 10 and 16 only for the purpose of clarifying the invention, and not to change the scope of the claims in any manner whatsoever. To the extent the rejection may apply

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to the amended claims, and to independent claim 22, the Applicants respectfully traverse the rejection.

In his statement of the reasons for rejection, the Examiner reiterated guidelines for determining whether a computer implemented process is statutory patentable subject matter, namely whether the claimed process "manipulate[s] data representing physical objects or activities, in order to achieve a practical application..." As the Applicants will show below for each of their independent claims, the process recited therein clearly includes manipulation of data representing physical objects or acts, and so fall within the scope of statutory subject matter.

Claim 1 recites a method for determining an axial force acting on each one of a plurality of roller cones on a drill bit. The method of claim 1 includes simulating the drilling of an earth formation by the drill bit. Simulating, as recited in claim 1, includes selecting a bit design parameter and a characteristic of an earth formation to be simulated as being drilled by the bit. The parameters of a crater formed when each cutting element on the bit contacts the formation are calculated during the simulation. The bit is simulated as being incrementally rotated, and the calculations are performed again. The axial forces acting on each cutting element are calculated during each element of the simulation, and are ten combined to determine a total axial force acting on each one of the roller cones on the bit. The parameters used in the simulation and calculated as a result of the Applicants' claimed method clearly <u>do</u> represent physical objects or activities. For example, an axial force acting on each roller cone of a drill bit is a physical activity. A geometry of at least one cutting element, as recited in claim 1, clearly is a representation of a physical object, just as is the at least one characteristic of an earth formation as recited in claim 1. The invention recited in claim 1 clearly has practical application, namely, to determine what axial forces act on each one of a plurality of roller cones on a roller cone bit without the need to explicitly measure such forces in an actual bit. The invention of claim 1 clearly has practical application in the improvement of drill bit design, for example. Accordingly, the invention recited in claim 1 is not merely an abstraction or a mathematical operation unlimited by a practical application representing real physical parameters, acts or objects. The Applicants believe that the Examiner may be misapplying the "safe harbor" provisions of MPEP 2106(IV)(B)(2) (b)(I). That section of MPEP explains two cases which *per se* provide that a claim recites statutory subject matter, but they do not recite the <u>only</u> cases

where computer implemented processes recite statutory subject matter. Accordingly, the invention of claim 1, being limited to manipulation of data representing defined physical objects, is clearly within the scope of MPEP guidelines on statutory computer implemented processes. Claims 2-4 depend from a base claim which is allowable, and should be allowable for at least the same reasons.

Claim 5, amended only for clarity, recites an invention similar in nature to the invention of claim 1, the difference being that a volume of formation cut by each roller cone on the bit is the calculated result, rather than the axial force on the individual cones on the drill bit. Volume of formation cut is clearly a parameter related to a physical object. Accordingly, claim 5 also recites statutory subject matter for at least the same reasons as recited with respect to claim 1. Claims 6-9 depend from a patentable base claim and should be patentable for at least the same reasons.

Claim 10 has also been amended only to clarify the invention and not to change its scope. Claim 10 is similar in nature to claim 1, but includes therein adjusting at least one design parameter of the drill bit, and repeating simulating the drilling (including calculating axial forces on each roller cone) until axial forces are substantially balanced between roller cones on the drill bit. Claim 10, therefore, recites a direct practical application of the simulation method recited in claim 1, namely that design parameters are adjusted so that axial forces on the bit are substantially balanced between the cones. Clearly, this also is within the scope of MPEP guidelines on statutory computer processes, in that the parameters entered, and the results obtained represent physical objects and acts. Accordingly, claim 10 recites patentable subject matter. Claims 11-15 depend from al allowable base claim, and should be allowable for at least the same reasons.

Claim 16 has also been amended to clarify the invention and not to change its scope. Claim 16 is analogous to claim 5, with the additional limitations that a bit design parameter is adjusted, and simulation of drilling is repeated until a volume of formation cut by each roller cone on the bit is substantially balanced between the cones. Claim 16 recites statutory subject matter for the same reasons as explained with respect to claims 5 and 10. Claims 17-21 depend from an allowable base claim and should be allowable for at least the same reasons.

Claim 22 recites:

A method for optimizing a design of a roller cone drill bit,
comprising:
simulating the bit drilling through a selected earth formation;
adjusting at least one design parameter of the bit;
repeating the simulating the bit drilling; and
repeating the adjusting and simulating until an optimized design is determined.

Claim 22 recites a statutory computer implemented process for the same reasons as explained with respect to claims 10 and 16. More specifically, a computer implemented method for simulating drilling of an earth formation is used to optimize the design of a drill bit. Just as is the case for claims 10 and 16, the result of the method of claim 22 is a set of parameters which represent a physical object, namely a drill bit expected to have improved drilling performance.

Please apply any charges not covered, or any credits, to Deposit Account 50-0591 (Reference Number 05516/056002).

Respectfully submitted,

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Marked-Up Version of Claims

1. (Amended) A method for determining an axial force acting on each one of a plurality of roller cones on a roller cone drill bit during drilling, comprising:

simulating drilling of an earth formation by the roller cone bit, the simulating comprising calculating, from a geometry of cutting elements on each of the roller cones and **at least one characteristic of** an earth formation being drilled by the drill bit, an axial force acting on each of the cutting elements;

simulating incrementally rotating the bit and recalculating the axial forces acting on each of the cutting elements;

repeating the **simulating the** incrementally rotating and recalculating for a selected number of incremental rotations; and

combining the axial force acting on the cutting elements on each one of the roller cones **to determine the axial force acting on each of the roller cones**.

5. (Amended) A method for determining a volume of formation cut by each one of a plurality of roller cones on a drill bit drilling in earth formations, comprising:

selecting bit design parameters, comprising at least a geometry of a cutting element on the drill bit;

selecting **at least one characteristic of** an earth formation **to be simulated as being drilled by the drill bit**;

simulating drilling of the earth formation, the simulating comprising calculating from the selected bit design parameters and the selected earth formation **characteristic**, parameters for a crater formed when each one of a plurality of cutting elements on each of the roller cones contacts the earth formation, the parameters including at least a volume of the crater[;]**,**

simulating incrementally rotating the bit, and repeating the calculating of the crater parameters for a selected number of incremental rotations; and

combining the volume of each crater formed by each of the cutting elements on each of the roller cones to determine the volume of formation cut by each of the roller cones.

10. (Amended) A method for balancing axial forces acting on each one of a plurality of roller cones on a roller cone drill bit during drilling, comprising:

simulating the drill bit drilling through an earth formation, the simulating comprising calculating, from a geometry of cutting elements on each of the roller cones and **at least one characteristic of** an earth formation **simulated as** being drilled by the drill bit, an axial force acting on each of the cutting elements[;]**,**

simulating incrementally rotating the bit and recalculating the axial forces acting on each of the cutting elements; repeating the incrementally rotating and recalculating for a selected number of **simulated** incremental rotations;

combining the axial force acting on the cutting elements on each one of the roller cones; and

adjusting at least one bit design parameter, and repeating the **simulating** **[calculating the axial force, incrementally rotating and combining the axial force,]** until a difference between the combined axial force on each one of the roller cones is less than a difference between the combined axial force determined prior to adjusting the at least one initial design parameter.

16. (Amended) A method for balancing a volume of formation cut by each one of a plurality of roller cones on a drill bit drilling in earth formations, comprising:

selecting bit design parameters, comprising at least a geometry of a cutting element on the drill bit;

selecting **at least one characteristic of** an earth formation **to be simulated as being drilled by the drill bit**;

simulating drilling of the drill bit through the earth formation, the simulating comprising calculating from the selected bit design parameters and the selected earth formation **characteristic**, parameters for a crater formed when each one of a plurality of cutting elements on each of the roller cones contacts the earth formation, the parameters including at least a volume of the crater[;],

simulating incrementally rotating the bit, and repeating the calculating of the crater parameters for a selected number of **simulated** incremental rotations;

combining the volume of each crater formed by each of the cutting elements on each of the roller cones to determine the volume of formation cut by each of the roller cones; and

adjusting at least one of the bit design parameters, and

repeating the **[calculating the crater volume, incrementally rotating and combining the volume]** **simulating** until a difference between the combined volume cut by each of the cones is less than the combined volume determined prior to the adjusting the at least one of the bit design parameters.